DESCRIPTION

TWO-WAY WARP KNITTED FABRIC

Technical Field

The present invention relates to a warp knitted fabric stretchable in two directions.

Prior Art

A stretch woven fabric (knitted fabric) that is elongated in the warp and weft directions is termed a two-way stretch woven fabric (knitted fabric) (refer to Table 1.74 on pages 139 to 140 of Handbook of Fiber [edited by the Society of Fiber, second edition, Maruzen Co., Ltd., Feb. 15, 1995] and to pages 41 to 49 in "Fundamental Knowledge of Textile Products" edited by Japan Fiber Control Society, Japan Clothing Control Society, 1985). In particular, a warp knitted union fabric of elastic yarns is generally termed a two-way warp knitted fabric, and a warp knitted texture which is formed by knitting a nylon fiber and an elastic fiber and in which the elastic yarn forms a needle loop is often used for shorts, lingerie, girdles and brassieres in underwear applications, for swimwear, skiwear, skate wear, diving wet suits and cycling pants in sports applications, is used as coated and laminated fabrics in outerwear applications such as jumpers. In general, articles prepared from a two-way warp knitted fabric material showing an elongation from about 100 to 300% in the warp direction and an elongation from about 50 to 200% in the weft direction are used.

A warp knitted union fabric of nylon-elastic yarns have the following disadvantages specific to a nylon fiber. The knitted fabric tends to yellow when heat set during dyeing or exposed to NOx gas during storage of the products and the fabric is discolored when contacted with chlorinated water because the fabric is dyed with an acid dye. In order to overcome such disadvantages,

countermeasures such as those mentioned below are taken. The knitted fabric is heat set at low temperature. The fabric is completely closed packaged for the purpose of preventing the final products from yellowing. A fixing agent is used to prevent discoloration caused by chlorinated water. Accordingly, it takes much labor to treat and finish the products.

Production of a two-way warp knitted fabric has been attempted, while avoiding the use of a nylon fiber that is likely to yellow and likely to be discolored with chlorinated water, by knitting of a polyethylene terephthalate fiber and an elastic fiber. Although the use of a polyethylene terephthalate fiber can prevent the fiber from yellowing, the resultant fabric loses a soft feeling that is characteristic of nylon fiber, and gives a hard feeling. Even when the finished fabric density is made coarse by conducting loose knitting in order to obtain a knitted fabric that gives a soft feeling, curling defects are formed. A knitted fabric giving a soft feeling has never been obtained.

A polytrimethylene terephthalate fiber is known as a polyester fiber that does not yellow, similarly to the polyethylene terephthalate fiber, and has a low Young's modulus.

A two-way warp knitted fabric formed with a polytrimethylene terephthalate yarn particularly tends to form fabric defects termed wavy edges (curls) at the edges thereof. Occurrence of curls impairs the operation efficiency during sewing, and sometimes makes sewing the fabric impossible. When a fiber is knitted to form a loop, a force that tends to bring the strain thus formed back to a stabilized state is produced by the stiffness of the yarn. A curl is formed when the stretch balance between a force on the needle side of a single face warp knitted fabric and a force on the sinker loop side is lost. Although the curling can be reduced to zero by making the knitted fabric density extremely high the

fabric then gives a hard feeling and is low in stretchability. Moreover, there is another method wherein the heat setting property of the yarn is utilized, and the yarn is stabilized to suppress occurrences of curls by heat setting the fabric at about 180°C. However, the heat setting property of a polytrimethylene terephthalate fiber is not satisfactory, and the stretch balance is lost even when the fabric is heat set at temperature of 180°C or more because the fabric easily stretches and shrinks; therefore, the curling occurs.

Disclosure of the Invention

An object of the present invention is to provide a two-way warp knitted fabric that solves the above problems of a conventional two-way warp knitted fabric, that does not yellow, that gives a soft feeling, and that is substantially prevented from curling, by simple means.

The present inventors have discovered that the present invention can be achieved by restricting the number ratio of courses to wales in a warp knitted union fabric formed with a polyester yarn composed of a polytrimethylene terephthalate and an elastic yarn, and the present invention has thus been achieved.

The present invention provides a two-way warp knitted fabric with a warp knitted fabric construction formed by knitting a polytrimethylene terephthalate yarn as a front yarn and an elastic yarn as a back yarn, which fabric has a knitted fabric density ratio from 1.55 to 2.35 calculated from the following formula (1):

knitted fabric density ratio = [(number of courses)/2.54 cm]/[(number of wales)/2.54 cm] (1)

The present invention will be explained in more detail.

In the present invention, a polytrimethylene terephthalate fiber designates a polyester fiber comprising trimethylene terephthalate units as principal

repeating units. The polytrimethylene terephthalate fiber contains about 50% or more by mole, preferably 70% or more by mole, more preferably 80% or more by mole, still more preferably 90% or more by mole of trimethylene terephthalate units, and further contains in total, as other remaining components, about 50% or less by mole, preferably 30% or less by mole, more preferably 20% or less by mole, still more preferably 10% or less by mole of an acid component and/or a glycol component that will be described later.

The polytrimethylene terephthalate fiber may take the shape of either a filament yarn or a staple fiber. The fiber may be uniform, or thick and thin in the longitudinal direction. A filament of the fiber may have a round-shaped, a triangle-shaped, a L-shaped, a T-shaped, a Y-shaped, a W-shaped, an eight leaf-shaped, a flat, a polygonal (e.g., dog bone-shaped), multi-leaf-shaped, a hollow or an indefinitely shaped cross section. However, for underwear, sports or outerwear applications, the yarn preferably is a filament yarn that is uniform in the longitudinal direction, and the filaments are preferably not round. The single filament size can be from 0.1 to 5.6 dtex in terms of single yarn denier. A yarn thickness of about 33 to 110 dtex is suitable.

The shape of a polytrimethylene terephthalate-based yarn to be knitted into a two-way warp knitted fabric can be a spun yarn such as a ring spun yarn and an open-end spun yarn, a multifilaments flat yarn (including an extremely thin yarn), a soft twist yarn, a hard twist yarn, a combined filaments yarn, a false twist yarn (including a stretch false twist yarn), a fluid-jet texturized yarn, and the like yarn. In addition, the two-way warp knitted fabric of the present invention may be made to include another yarn such as a natural yarn, represented by wool, usually in an amount range of 30 mass% or less so long as the object of the present invention is not impaired, by means such as a textile

blend (silo spun, silo fill, etc.), an interlaced combination (a different shrinkage combined filaments yarn with a high shrinkage yarn, etc.), a twisted combination, a composite false twisting (elongation-differenced false twisting, etc.), fluid-jet texturizing with two feeds, and the like.

In the present invention, an elastic yarn to be knitted with the polytrimethylene terephthalate-based yarn can be an optional elastic yarn such as a polyurethane-based yarn and a polyether ester-based yarn showing an elastic stretchability of 100% or more in terms of breaking elongation, and having a size of from 11 to 78 dtex, preferably 17 to 44 dtex. There is no specific limitation on the polymer and spinning method so long as the fiber is an ordinary polyurethane-based elastic fiber.

The elastic fiber is preferably a fiber the stretchability of which is not impaired in the presetting step, during dyeing, usually at treating temperature near 190°C. The form of the elastic fiber is a bare yarn, a covering yarn or a twisted yarn, but there is no specific limitation.

The two-way warp knitted fabric according to the present invention is a knitted fabric formed in a two-bar-fabric construction that are composed of a closed lap and/or an open lap obtained by threading polytrimethylene terephthalate yarns through the front guide bar and elastic yarns through the back guide bar on a single needle bar warp knitting machine. Therefore, the two-way warp knitted fabric according to the present invention is formed with a fabric construction that can be knitted with two bars. Typical examples of a usable fabric construction include double denvy, double code, half tricot stitch (lock knit), back half, queen's code, satin and double atlas. The stretchability and curling property of the two-way warp knitted fabric greatly changes depending on the fabric construction. For

example, when the underlap of a front construction is one needle interval or less, the fabric is thin and tends to curl. When it is three needle interval or more, the fabric is thick, gives a hard feeling, and shows lowered stretchability. When the underlap of a back construction is a zero needle interval, stretchability in the weft direction cannot be obtained. When it is a two needle interval or more, adjacent elastic yarns in the fabric are melt bonded at contacted portions and cross portions with a heat during dyeing, and the fabric gives a hard feeling. Accordingly, in view of the selection of a combination of the number of underlaps, satin and half tricot stitch are preferred, and a half tricot stitch is more preferred, though the fabric construction is not restricted thereto.

Preferred knitted fabric constructions are exemplified below without any intention of restriction.

(1) Front bar two needle interval fabric construction, namely, a knitted fabric that is a so-called half tricot stitch:

front 10/23, and back: 12/10.

(2) Half tricot stitch obtained by shifting the positional relationship between the front construction and the back construction:

front: 10/23; and back: 10/12.

(3) A half tricot construction obtained by combined deformation of an open lap and a closed lap:

front 10/23; and back 21/01.

In the present invention, the ratio of the number of courses to that of wales, the courses and wales forming a unit surface area of a finished knitted fabric, namely, the knit density ratio calculated from the formula (1) is adjusted to 1.55 to 2.35. A soft feeling specific to a polytriethylene terephthalate fiber is then maintained on the knitted fabric surface, and a two-way warp knitted fabric in which curls are suppressed is formed.

Knit density ratio = [(number of courses)/2.54 cm]/[(number of wales)/2.54 cm] (1)

In the present invention, the knitted fabric density ratio is a density ratio of a knitted fabric subsequent to dyeing finishing, and a knitted fabric must be designed while the shrinkage and the like of the knitted fabric are taken into consideration when the fabric is to be knitted. The number of loops per 2.54 cm is used for the calculation of a knitted fabric density ratio, and the ratio is defined as a value obtained by dividing a density in the warp direction that is the number of courses/2.54cm by a density in the weft direction that is the number of wales/2.54cm.

When the knitted fabric density ratio is less than 1.55, curls tend to be formed in the right and left end portions in the weft direction of the two-way warp knitted fabric. Moreover, when the knitted fabric density ratio is larger than 2.35, the curling tends to occur in the upper and lower end portions in the warp direction thereof. A preferred knitted fabric density ratio is from 1.65 to 2.25.

The object of the present invention can basically be achieved by designing the knitted fabric on the basis of the knitted fabric density ratio of the invention even when the gauge of the knitting machine changes. For example, when the knitting machine is of 28 gauge, the most preferable knitted fabric density ratio is from 1.56 to 1.93. When the knitting machine is of 36 gauge, the most preferable knitted fabric density ratio is from 1.85 to 2.35. That is, when the gauge becomes finer, the most preferable range of the knitted fabric density ratio tends to become larger.

One example of the designing of a knitted fabric that makes the knitted fabric density ratio of a two-way warp knitted fabric from 1.55 to 2.35 will be explained below. The runner length (also termed a run-in, and being one index indicating a yarn length that forms one

stitch, the stitch becoming coarse when the numerical value of the same texture becomes large, showing a yarn length per 480 courses in the warp knitting technology) of an elastic yarn during knitting, is made large in comparison with the runner length in a knitted union fabric of a nylon yarn or a polyethylene terephthalate yarn, and an elastic yarn, and knitting must be carried out while the course on the machine (being one index showing the height of one stitch during knitting, and representing a high knit fabric density when the number of courses that is a wound amount of the knitted fabric is large) is being made coarse. The runner length and the course on the machine of a polytrimethylene terephthalate yarn and an elastic yarn must be set in such a manner that the two-way warp knitted fabric thus formed has a given density ratio when subjected to the following procedures: the fabric is relax scoured at 90°C for 1 minute; the fabric is then preset so that the density ratio becomes within that of the present invention during tentering in the presetting step subsequent to scouring; the fabric is finish set with approximately the same density as the width and length subsequent to dyeing or with the same density ratio as in presetting.

Although a setting temperature from 150 to 200°C, and a setting period of time from 30 to 60 sec can be used, a preferred temperature is near 190°C during presetting, and near 170°C during finish setting. The resultant knitted fabric can be well set, and causes no problem about color fastness. When the knitted fabric is to be dyed, an optional dyeing machine can be used. However, use of a liquid-jet dyeing machine is preferred because uneven dyeing hardly even takes place.

The two-way warp knitted fabric of the present invention can be knitted with a tricot knitting machine or a raschel knitting machine, and there is no specific limitation on the gauge of the knitting machine.

However, a knitting machine of 18 to 40 gauge/2.54 cm should optionally be selected in accordance with the thickness of a yarn to be used.

As explained above, a two-way warp knitted fabric producing no curlings, giving a soft feeling, and causing no problem about shrinkage such as washing shrinkage and pressing shrinkage can be obtained through adjustment of the knit density.

A two-way warp knitted fabric having a knitted fabric density from 1.55 to 2.35 can be prepared from a two-way warp knitted fabric with its front texture formed with a nylon yarn and a polyethylene terephthalate yarn. However, when a knitted fabric with its knitted fabric density in the range of the present invention is produced, the two-way warp knitted fabric, in which a nylon yarn is used, is an unsatisfactory one having a problem with yellowing. On the other hand, a knitted fabric in which a polyethylene terephthalate yarn is used alone gives a hard feeling. When a coarser knitted fabric is prepared for the purpose of obtaining a fabric giving a soft feeling, curls come out.

As explained above, the polytrimethylene terephthalate fiber used in the present invention can comprise, in addition to the repeating units of a polytrimethylene terephthalate, a copolymer of terephthalic acid or its functional derivative, and trimethylene glycol or its functional derivative as another acid component and/or a glycol component (as third components). In the course of synthesis process of copolymer, a copolymerized polyester may be formed by adding suitable one, or two or more of third components. Alternatively, such a polyester other than a polytrimethylene terephthalate as polyethylene terephthalate, a nylon and a polytrimethylene terephthalate may be separately synthesized; the resultant polymers may be blended, or composite spun (sheath-core, side-by-side or the like). Examples of the

third component to be added include aliphatic dicarboxylic acids such as oxalic acid and adipic acid, alicyclic dicarboxylic acids such as cyclohexanedicarboxylic acid, aromatic dicarboxylic acids such as isophthalic acid and sodiumsulfoisophthalic acid, aliphatic glycols such as ethylene glycol, 1,2-propylene glycol and tetramethylene glycol, alicyclic glycols such as cyclohexanedimehthanol, aliphatic glycols including an aromatic group such as 1,4-bis(β-hydroxyethoxy)benzene, polyether glycols such as a polyethylene glycol and a polypropylene glycol, aliphatic oxycarboxylic acids such as ω-oxycaproic acid and aromatic oxycarboxylic acids such as p-oxybenzoic acid. Moreover, a compound such as benzoic acid or glycerin having one, or three or more ester-forming functional groups can also be used so long as the resultant polymer is substantially linear.

A polytrimethylene terephthalate fiber may be produced by any of the following methods: a draw-twisting method wherein an undrawn yarn is obtained at a winding rate of about 1,500 m/min, and the yarn is drawn and twisted in a ratio of about 2 to 3.5; a direct drawing method (spin draw method) in which spinning, and drawing and twisting are continuously connected; and a high speed spinning method (spin take up method) in which the winding speed is 5,000 m/min or more. A polytrimethylene terephthalate-based fiber can be obtained by spinning a resin composition containing delustering agents such as titanium oxide, stabilizing agents such as phosphoric acid, ultraviolet ray absorbing agents such as a hydroxybenzophenone derivative, nucleating agents such as talc, lubricating agents such as Aerosil, antioxidants such as a hindered phenol derivative, flame retardants, antistatic agents, pigments, fluorescent brighteners, infrared ray absorbing agents, defoaming agents and the like.

Best Mode For Carrying Out the Invention

The idea of the present invention will be made more specific and clear by making reference to examples. The present invention is, however, not restricted thereto. In addition, the preparation of a yarn used in the examples, the measurement of the size of an elastic yarn and the evaluation of the properties of a two-way warp knitted fabric are described below.

(1) Preparation of Polymethylene Terephthalate Yarn

A polytrimethylene terephthalate showing an η_{sp}/c = 0.5 is spun at a spinning temperature of 265°C at a rate of 1,200 m/min to give an undrawn yarn. The yarn is subsequently drawn and twisted at a hot roll temperature of 60°C and a hot plate temperature of 140°C at a drawing speed of 800 m/min with a draw ratio of 3 to give two stretched yarns of 40 dtex/34 f and 56 dtex/36 f. The stretched yarn of 40 dtex/34 f has a strength of 2.7 cN/dtex, an elongation of 44%, an initial tensile resistance of 25 cN/dtex and an elastic recovery of 97% when stretched by 10%. The stretched yarn of 56 dtex/36 f has a strength of 2.8 cN/dtex, an elongation of 46%, an initial tensile resistance of 26 cN/dtex and an elastic recovery of 98% when stretched by 10%. In addition, the elastic recovery of a yarn at the time of stretching by 10% is obtained in the following manner. An initial load of 0.01 cN/dtex is applied to the sample, and stretched at a constant stretching rate of 20%/min; the sample is conversely allowed to shrink at the same rate when the stretch ratio reaches 10%. As a result, a stress-strain curve is depicted. The elastic recovery is calculated from the following formula:

elastic recovery at the time of a stretch ratio of 10% = (10 - L)/10 x 100 (%)

wherein L is a residual stretch ratio when the stress is lowered to 0.01 cN/dtex that is equal to the initial load during shrinking.

The viscosity of polymer, ηsp/c is determined by dissolving a polymer in o-chlorophenol at 90 degree Celsius to prepared a solution at a concentration of 1 g/dl which is then transferred to Ostowald viscometer to measure at 35 degree Celsius, and calculating using the data obtained according to the following formula.

$$\eta sp/c = (T/T0 \quad 1)/C$$

(T: falling time of the solution, C: concentration of the solution [g/dl])

(2) Measurement of Size of Elastic Yarn

An elastic yarn is allowed to stand on a straight line without tension and load in an atmosphere at 20°C with an RH (relative humidity) of 65% to be allowed to shrink. Ten pieces of the yarn each 1 m long prepared by cutting the yarn are weighed, and the size is determined by the weight of the yarn per 10,000 m calculated from the weighed value.

(3) Evaluation of a two-way warp knitted fabric in examples is made by the following methods.

[1] Evaluation of Curl Manifestation

Two square test pieces, 100 mm (warp direction) x 100 mm (weft direction), of a two-way warp knitted fabric are prepared. The two test pieces are allowed to stand still on a horizontal stool in an atmosphere at 20°C with its humidity conditioned to an RH of 65% while the needle loop side and sinker loop side are placed upward. Four hours after allowing the test pieces to stand still, the results are judged according to the following criteria. A protractor is attached to a cured portion, and the angle (θ) made by the tangential line of the tip of the cured portion with the horizontal stool is determined. When the curl angle is 90° or more, the treatment of the fabric during sewing causes a problem. The rating criteria are as follows.

5 The curl angle is less than 30°.

4 The curl angle is less than 45°.

3 The curl angle is less than 90°.

2 The curl angle is less than 130°.

1 The curl angle is 130° or more.

[2] Evaluation of Feeling

The sensory test results of hand feeling by 10 panelists are judged from the average value. The fabric having the same construction prepared from a nylon fiber is used as a reference feeling. A sample excellent in a soft hand feeling is evaluated to be from 4 to 5 points. A sample that can be hardly judged to be excellent or poor therein is evaluated to be 3 points. A sample that is judged to be poor therein is evaluated to be from 1 to 2 points. The sample is judged by the total points.

A sample is judged by handling according to the following criteria.

5 points The sample gives an extremely soft and smooth feeling.

4 points The sample gives a soft and smooth feeling.

3 points The sample gives a feeling that is the same as that of a knitted fabric formed from a nylon fiber and having the same texture.

2 points The sample gives a hard feeling.

1 point The sample gives a hard feeling, and is inappropriate to underwear applications.

[3] Evaluation of Yellowing Tendency

Evaluation of a yellowing tendency of a sample is made in accordance with the weak test method in the JIS L-0855 test method of color fastness against nitrogen oxide gas. The results are judged by comparing the YI value that is obtained by a Macbeth colorimeter (manufactured by Macbeth) with that of a non-treated sample. When the YI value of a sample is larger, the tendency toward yellowing thereof is more significant.

[4] Evaluation of Heat Formability

A heat forming test machine manufactured by Daito is

used. A sample, 300 mm (warp direction) x 300 mm (weft direction), is prepared by cutting a fabric. The sample is fixed to a frame (200 mm (warp direction) x 200 mm (weft direction)) under a free tension. The sample is marked by pressing the central portion with a heated mold. The sample is then allowed to stand for 24 hours in an atmosphere at 20°C with an RH of 65%. The deformed amount and change in the feeling of the fabric are subsequently evaluated.

The test is conducted under the following conditions:

Heat forming test machine: a stretch forming machine manufactured by Daito;

Shape of the heater mold: a metal-made cylinder (50 mm in diameter and 30 mm in height);

Temperature: 180°C;

Period of time: 30 sec; and

Pressing depth: 20 mm

The rating criteria are as follows:

Good: the deformation amount of the sample is 18 mm or more, and the sample shows no change in the feeling; and

Poor: the deformation amount of the sample is less than 18 mm, and the sample shows a change in the feeling.

[5] Evaluation of Gigging (raising) property

The sinker loop surface of a gray fabric is gigged with a gigging test machine (trade name of KU-50 type, manufactured by Kanai juyo Kogyo Co., Ltd.) under the conditions of a loop pile, and the uniformity is evaluated and the thickness of the fabric is measured. A fabric showing a larger judgment criterion thickness shows a better gigging property.

Example 1

A polytrimethylene terephthalate yarn of 40 dtex/34 f was used as the front bar yarn. An elastic yarn obtained by warping a polyurethane-based elastic yarn

(trade name of Roica, manufactured by Asahi Chemical Industry Co., Ltd.) of 22 dtex with a draft ratio of 80% was used as the back bar yarn. A half tricot stitch was knitted.

The knitting conditions are as follows:

Knitting machine: tricot machine (manufactured by Carl Meyer) of 28 gauge/2.54 cm;

Texture: front: 10/23, and back:12/10

Runner lengths: front: 160 mm, and back: 90 mm

Courses on the machine: 76 courses/2.54 cm

The knitted fabric thus obtained under the knitting conditions was scoured at 90°C for 1 minute, and preset at 190°C for 45 sec. The density during presetting was set as follows: a (number of courses)/(number of wales) density ratio of 1.83; and 110 courses/2.54 cm x 60 wales/2.54 cm. The fabric was then dyed with a liquid-jet dyeing machine. The fabric was further finish set under the same conditions as in the presetting: 110 courses/2.54 cm, and 60 wales/2.54 cm. That is, the fabric was finish set with the same present length and same present width to give a two-way warp knitted fabric. The finished two-way knitted fabric had a basis of weight of 170 g/m^2 and a thickness of 0.61 mm. Various physical properties of the fabric were evaluated, and the results are shown in Table 1. The two-way warp knitted fabric thus obtained did not yellow, gave a soft feeling, did not produce a curling phenomenon, excelled in formability, and was most appropriate to underwear applications.

Examples 2 to 5

In Example 2, a sample was prepared in the same manner as in Example 1 except that the front runner was made short in comparison with that in Example 1 to form a gray fabric with a high density construction, and that the (number of courses)/(number of wales) density ratio was set at 1.93.

In Example 3, a sample was prepared in the same

manner as in Example 1 except that the front runner was made long in comparison with that in Example 1 to form a gray fabric with a low density, and that the (number of courses)/(number of wales) density ratio was set at 1.55.

In Example 4, a sample was prepared in the same manner as in Example 1, except that the back runner was made short in comparison with that in Example 1 to form a gray fabric with a high density construction, and that the (number of courses)/(number of wales) density ratio was set at 1.81.

In Example 5, a sample was prepared in the same manner as in Example 1, except that the back runner was made long in comparison with that in Example 1 to form a gray fabric with a low density, and that the (number of courses)/(number of wales) density ratio was set at 1.70.

The curl manifestation, feeling, yellowing tendency and formability of each of the finished knitted fabrics were evaluated. Table 1 shows the results thus obtained.

The finished two-way warp knitted fabrics did not yellow, gave a soft feeling, produced no curling, excelled in formability, and were most appropriate warp knitted fabrics for use in underwears.

Comparative Example 1

A sample knitted fabric was prepared in the same manner as in Example 1 except that a gray fabric with a high density was formed by making the back bar runner length short, and that the (number of courses)/(number of wales) density ratio was set at 2.37 during presetting to change the density of the finished knitted fabric. The curl manifestation, feeling, yellowing tendency and formability of the knitted fabric were evaluated. Table 1 shows the results thus obtained. The two-way warp knitted fabric thus obtained did not yellow, and gave a feeling as soft as that of the nylon. However, it produced a curling phenomenon, and became a warp knitted fabric inappropriate to underwear applications.

Comparative Example 2

A knitted fabric sample was prepared in the same manner as in Example 1 except that a gray fabric with a coarse density was formed by making the front bar runner length short, and that the (number of courses)/(number of wales) density ratio was set at 1.52 during presetting to change the density of the finished knitted fabric. The curl manifestation, feeling, yellowing tendency and formability of the knitted fabric were evaluated. Table 1 shows the results thus obtained.

The two-way warp knitted fabric thus obtained did not yellow, and gave a soft feeling. However, since it produced a curling phenomenon, and it became inappropriate to underwear applications. Moreover, the knitted fabric showed poor formability.

Example 6

A polytrimethylene terephthalate yarn of 40 dtex/34 f was used as the front bar yarn. An elastic yarn obtained by warping a polyurethane-based elastic yarn (trade name of Roica, manufactured by Asahi Chemical Industry Co., Ltd.) of 22 dtex with a draft ratio of 80% was used as the back bar yarn. A half tricot stitch was knitted.

The knitting conditions are as follows:

Knitting machine: a tricot machine of 36 gauge/2.54 cm;

Texture: front: 10/23, and back: 12/10,

Runner lengths: front: 160 mm, and back: 76 mm,

Courses on the machine: 80 courses/2.54 cm.

The gray knitted fabric thus obtained was relax scoured at 90°C for 1 minute, and preset at 190°C for 45 sec. The density during presetting was set as follows: a (number of courses/(number of wales) density ratio of 2.25; and 180 courses/2.54 cm x 80 wales/2.54 cm. The fabric was then dyed with a liquid-jet dyeing machine. The fabric was then finish set under the same conditions as in the presetting: 157 courses/2.54 cm x 70 wales/2.54 cm. The finished two-way warp knitted fabric had a basis

of weight of 138 g/m^2 and a thickness of 0.51 mm. Various physical properties of the fabric were evaluated, and the results are shown in Table 1.

Examples 7 to 8

In Example 7, a finished knitted fabric sample was prepared in the same manner as in Example 6 except that the front runner and the back runner were made short in comparison with those in Example 6 to form a dense gray fabric, and that the (number of courses)/(number of wales) density ratio was set at 2.35 to change the density of the finished fabric.

In Example 8, a finished knitted fabric sample was prepared in the same manner as in Example 6 except that the front and the back runner were made long in comparison with those in Example 6 to form a coarse gray fabric, and that the (number of courses)/(number of wales) density ratio was set at 1.85 to change the density of the finished fabric. The curl manifestation, feeling, yellowing tendency and formability of each of the finished knitted fabrics were evaluated. Table 1 shows the results thus obtained. The two-way warp knitted fabrics did not yellow, gave a soft feeling, produced no curling, excelled in formability, and were most appropriate to underwear and swimwear applications.

Comparative Example 3

A sample was prepared in the same manner as in Example 6 except that the front runner length and the back runner length were made long, that the (number of courses)/(number of wales) density ratio was set at a value as low as 1.54 during presetting, and that the density of the finished knitted fabric was varied. The curl manifestation, feeling, yellowing tendency and formability of the finished knitted fabric were evaluated. Table 1 shows the results thus obtained. The finished two-way warp knitted fabric did not yellow, and gave a soft feeling. However, it produced a curling phenomenon, and was inappropriate for use.

Comparative Example 4

A finished knitted fabric sample was prepared in the same manner as in Example 6 except that the back runner was made short to give a gray fabric having a high density, that the (number of courses)/(number of wales) density ratio was set at a value as high as 2.38 during presetting, and that the density of the finished knitted fabric was varied. The curl manifestation, feeling, yellowing tendency and formability of the finished knitted fabric were evaluated. Table 1 shows the results thus obtained. The finished two-way warp knitted fabric did not yellow, and gave a soft feeling. However, it produced curling, showed poor formability, and was inappropriate for use.

Example 9

A polytrimethylene terephthalate yarn of 56 dtex/36 f was used as the front bar yarn. An elastic yarn obtained by warping a polyurethane-based elastic yarn (trade name of Roica, manufactured by Asahi Chemical Industry Co., Ltd.) of 44 dtex with a draft ratio of 80% was used as the back bar yarn. A half texture was prepared by knitting the yarns.

The knitting conditions are as follows:

Knitting machine: tricot machine of 28 gauge/2.54 cm,

Texture: front: 10/23, and back: 12/10

Runner lengths: front: 165 mm, and back: 80 mm

Courses on the machine: 81 courses/2.54 cm.

The knitted fabric obtained under the above conditions was relax scoured at 90°C for 1 minute, and preset at 190°C for 45 sec. The density during presetting was set as follows: a (number of courses)/(number of wales) density ratio of 1.92; and 115 courses/2.54 cm x 60 wales/2.54 cm. The fabric was then dyed with a liquid-jet dyeing machine. The fabric was further finish set under the same number of courses/2.54 cm and the same number of wales/2.54 cm to give a two-way

warp knitted fabric. The finished two-way warp knitted fabric had a basis of weight of 227 g/m^2 and a thickness of 0.66 mm. Various physical properties of the fabric were evaluated, and the results are shown in Table 1.

The finished knitted fabric did not yellow, gave a soft feeling, produced no curling phenomenon, excelled in formability and a gigging tendency, and as most appropriate to underwear and swimwear applications.

Comparative Example 5

A knitted fabric was formed in the same manner as in Example 9 except that a nylon 6 yarn of 56 dtex/36 f was used as the front bar yarn. The results of evaluating the knitted fabric thus obtained are shown in Table 1. The knitted fabric gave a soft feeling. However, since the knitted fabric had the following disadvantages, it is difficult to handle: the fabric tended to yellow; it produced curling; and it showed poor setting and poor uniformity during gigging.

Comparative Example 6

A knitted fabric was prepared in the same manner as in Example 9 except that a polyethylene terephthalate yarn of 56 dtex/36 f was used as the front bar yarn.

The results of evaluating the knitted fabric thus finished are shown in Table 1. Although the finished knitted fabric did not yellow and produced no curling phenomenon, it gave a hard feeling and showed a poor gigging tendency though it had a good capacity for being set. The fabric therefore is not suitable for underwear and swimwear applications.

Example 10

A polytrimethylene terephthalate yarn of 56 dtex/36 f was used as the front bar yarn. An elastic yarn obtained by warping a polyurethane-based elastic yarn (trade name of Roica, manufactured by Asahi Chemical Industry Co., Ltd.) of 44 dtex with a draft ratio of 80% was used as the back bar yarn. A knitted fabric with a half texture was formed.

The knitting conditions are as follows:

Knitting machine: a tricot machine of 28 gauge/2.54 cm

Texture: front 10/23; back 12/10

Runner lengths: front 206 mm, and back 80 mm

Courses on the machine: 81 courses/2.54 cm.

The knitted fabric thus obtained was relax scoured at 90°C for 1 minute, and preset at 190°C for 45 sec. The density during presetting was set under the conditions: a (number of courses)/(number of wales) density ratio of 1.88; and 113 courses/2.54 cm x 60 wales/2.54 cm. The fabric was then dyed with a liquid-jet dyeing machine. The fabric was then finish set with the same number of courses/2.54cm and the same number of wales/2.54 cm as in the presetting to give a two-way warp knitted fabric. The finished two-way warp knitted fabric thus obtained had a basis of weight of 280 g/m^2 and a thickness of 0.70 mm. Various physical properties of the fabric were evaluated, and the results are shown in Table 1.

The finished knitted fabric did not yellow, gave a soft feeling, produced no curling, excelled in formability and a gigging tendency, and was a warp knitted fabric most appropriate to underwear and swimwear applications.

Example 11

A polytrimethylene terephthalate yarn of 56 dtex/36 f was used as the front bar yarn. An elastic yarn obtained by warping a polyurethane-based elastic yarn (trade name of Roica, manufactured by Asahi Chemical Industry Co., Ltd.) of 44 dtex with a draft ratio of 80% was used as the back bar yarn. A knitted fabric with a half texture was formed under the following conditions:

Knitting machine: tricot machine of 28 gauge/2.54 cm

Knitting texture: front: 10/45, and back 12/10

Runner lengths: front 250 mm, and back: 80 mm

Courses on the machine: 81 courses/2.54 cm.

The knitted fabric thus obtained was relax scoured at 90°C for 1 minute, and preset at 190°C for 45 sec. The density during presetting was set under the conditions: 110 courses/2.54 cm x 60 wales/2.54 cm. The fabric was then dyed with a liquid-jet dyeing machine. The fabric was then finish set with the same number of courses/2.54cm and the same number of wales/2.54 cm as in the presetting to give a two-way warp knitted fabric. The finished two-way warp knitted fabric thus obtained had a basis of weight of 280 g/m^2 and a thickness of 0.72 mm. Various physical properties of the fabric were evaluated, and the results are shown in Table 1.

The finished knitted fabric did not yellow, gave a soft feeling, produced no curling phenomenon, excelled in setting and a gigging tendency, and was a stretchable warp knitted fabric most appropriate to underwear and swimwear applications.

Comparative Example 7

A knitted fabric was formed in the same manner as in Example 10 except that a nylon 6 yarn of 56 dtex/36 f was used as the front bar yarn. Although the finished knitted fabric gave a soft feeling, it tended to yellow, and curls were formed. A sufficient deepness could not be obtained, and the knitted fabric showed poor formability and a poor gigging tendency and was difficult to handle.

Comparative Example 8

A knitted fabric was formed in the same manner as in Example 10 except that a polyethylene terephthalate yarn of 56 dtex/36 f was used as the front bar yarn. Although the knitted fabric showed good formability, it showed a poor gigging tendency, and gave a hard feeling. Accordingly, the fabric was not suitable for use.

Comparative Example 9

A knitted fabric was prepared in the same manner as in Example 9 except that a polyethylene terephthalate yarn of 56 dtex/36 f was used as the front bar yarn, that

the front runner and back runner were made longer than those in Comparative Example 6 to form a coarse gray fabric, and that the density was set at 94 courses/2.54 cm and 60 wales/2.54 cm during presetting.

Table 1 shows the results of evaluating the finished knitted fabric. The fabric did not yellow, and gave a softer feeling than the knitted fabric in Comparative Example 6. However, the fabric gave no numeric (phonetic; waxy to touch feeling specific to nylon. The fabric was not suitable for underwear and swimwear applications because it showed poor formability and a poor gigging tendency, and because curls were formed.

Table 1 Yarns Forming Knitted Fabrics, Properties Knitted Fabric and Evaluation of Performances

	Yarn (F)			Gauge /2.5 cm	Runner length		Properties of knitted fabric				
	Yarn	Size dtex	Ampli-tude needles		(F) mm Hard yarn	(B) mm Elastomeric yarn	Basis of weight g/m^2	Thick-ness mm	Courses (c) /2.5 cm	Number of Wales (c) /2.5 cm	c/w Den-sity ratio
Ex.1	PTT	40	2	28	160	90	170	0.61	110	60	1.83
Ex.2	PTT	40	2	28	155	90	158	0.57	116	60	1.93
Ex.3	PTT	40	2	28	170	90	190	0.64	94	60	1.55
Ex.4	PTT	40	2	28	160	80	181	0.62	109	60	1.81
Ex.5	PTT	40	2	28	160	95	177	0.65	102	60	1.70
Ex.6	PTT	40	2	36	126	76	138	0.51	180	80	2.25
Ex.7	PTT	40	2	36	122	75	149	0.56	188	80	2.35
Ex.8	PTT	40	2	36	135	80	135	0.51	148	80	1.85
Ex.9	PTT	56	2	28	165	80	227	0.66	115	60	1.92
Ex.10	PTT	56	3	28	190	80	250	0.70	113	60	1.88
Ex.11	PTT	56	4	28	220	80	280	0.72	110	60	1.83
C.Ex.1	PTT	40	2	28	160	70	191	0.67	142	60	2.37
C.Ex.2	PTT	40	2	28	186	90	162	0.58	91	60	1.52
C.Ex.3	PTT	40	2	36	141	98	132	0.50	123	80	1.54
C.Ex.4	PTT	40	2	36	120	71	155	0.58	190	80	2.38
C.Ex.5	NY	40	2	28	160	90	161	0.67	110	60	1.83
C.Ex.6	PET	40	2	28	160	90	162	0.68	115	60	1.92
C.Ex.7	NY	56	3	28	190	80	251	0.71	113	60	1.88
C.Ex.8	PET	56	3	28	190	80	253	0.70	112	60	1.87
C.Ex.9	PET	56	2	28	170	90	130	0.64	94	60	1.56

Table 1 Yarns Forming Knitted Fabrics, Properties of Knitted Fabrics, and Evaluation of Performances (Continued)

	Feeling	Curl manifestation	Difference of Yellowing YI value	Formability	Gigging tendency	
					Thickness	Uniformity
Ex.1	5	5	0.6	o	-	-
Ex.2	5	5	0.6	o	-	-
Ex.3	4	4	0.6	o	-	-
Ex.4	5	5	0.6	o	-	-
Ex.5	5	5	0.6	o	-	-
Ex.6	5	5	0.6	o	-	-
Ex.7	5	4	0.6	o	-	-
Ex.8	5	5	0.6	o	-	-
Ex.9	5	5	0.6	o	0.78	o
Ex.10	4	5	0.6	o	0.83	o
Ex.11	4	5	0.6	o	-	-
C.Ex.1	3	1	0.6	o	-	-
C.Ex.2	4	2	0.6	x	-	-
C.Ex.3	3	1	0.6	o	-	-
C.Ex.4	4	2	0.6	x	-	-
C.Ex.5	3	1	10.4	x	0.77	x
C.Ex.6	1	4	0.6	o	0.70	x
C.Ex.7	3	1	10.4	x	0.80	x
C.Ex.8	1	4	0.6	o	0.75	x
C.Ex.9	3	1	0.6	x	0.70	x

Industrial Applicability

The two-way warp knitted fabric of the present invention does not yellow, gives a soft feeling and a unique surface touch that cannot be obtained from a knitted fabric in which a nylon yarn is used, and is a warp knitted fabric prevented from forming curls. The knitted fabric is therefore excellent in handling such as sewing, and is a stretchable warp knitted fabric most suitable for sports and clothing applications such as underwear and swimwear.